UB-Node of the George E. Brown Jr. Network for Earthquake Engineering Simulation (NEES)

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Credits*

- PI: Michel Bruneau
- Co-PI: Andrei Reinhorn
- Co-PI: Michael Constantinou
- Co-PI: Eddy Rojas
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* All from Department of Civil Structural and Environmental Engineering (CSEE) at University at Buffalo (UB)

Credits (part 2)

- Senior Investigators also listed in Proposal*
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  - Stuart Chen
  - Gary Dargush
  - Michael Gauss
  - George Lee
  - John Mander
  - Apostolos Papageorgiou
  - Rowland Richards
  - Larry Soong
  - Andrew Whittaker
  - Mark Pitman
  - Richard Cizdziel
  - Project Engineer (TBA)
  - Graduate Students

* All from Department of Civil Structural and Environmental Engineering (CSEE) at University at Buffalo (UB)

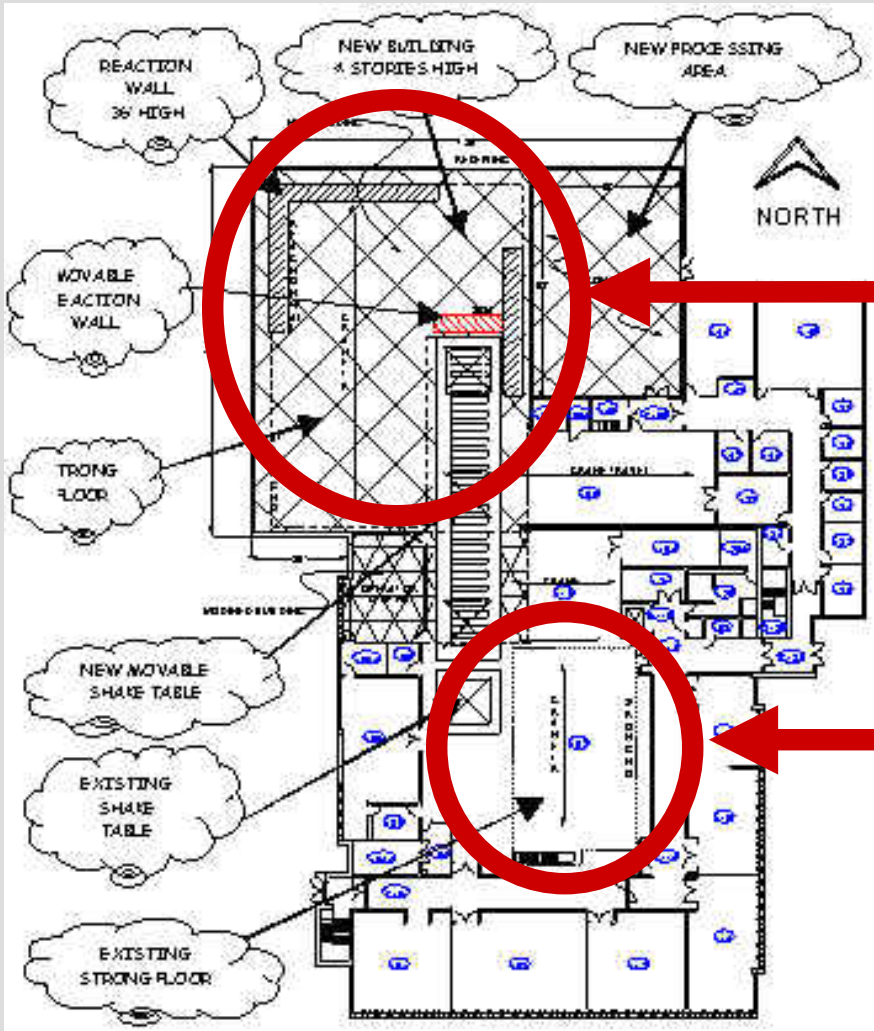
UB NEES Node Proposals

- Large-Scale High Performance Testing Facility towards Real-Time Hybrid Seismic Testing - $4,379,865
- Versatile High Performance Shake Tables Facility towards Real-Time Hybrid Seismic Testing - $6,160,785
- Sub-total: $10,540,650 (NSF)
- SUNY Construction Fund: $4,000,000
- Total: $14,540.650.00

The shopping list

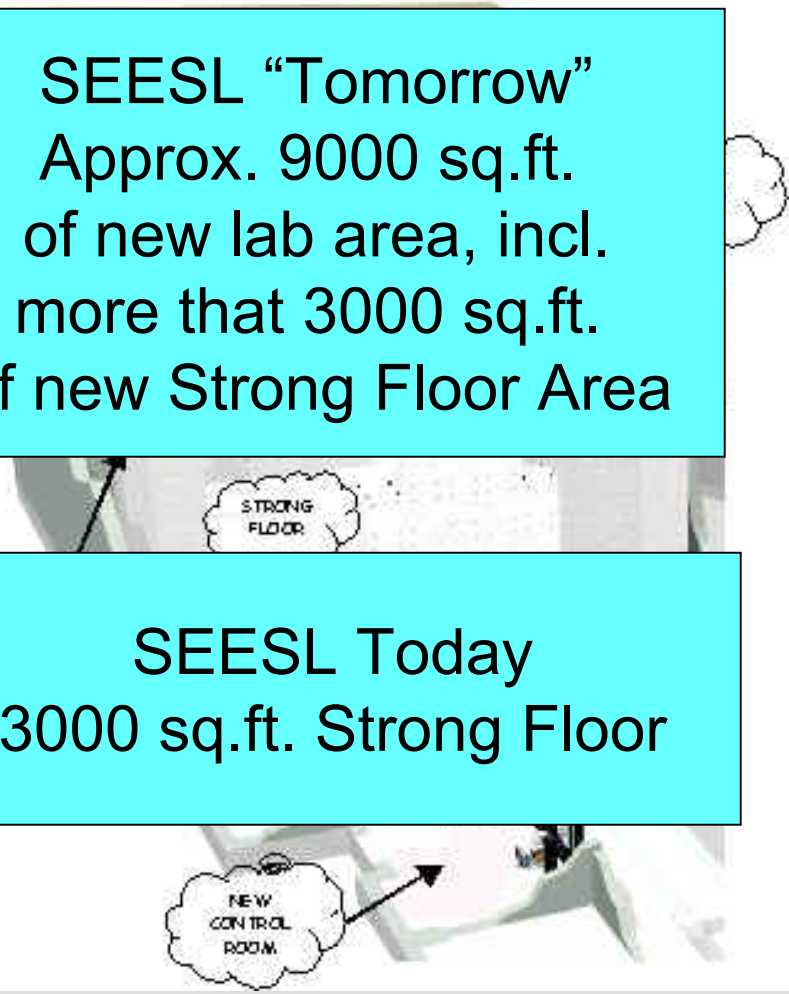
- Expansion to SEESL laboratory
- Upgrade of existing shake table
- New shake table “on tracks”
- New dynamic actuators
- New high capacity static actuators
- New testing capabilities, and most versatile earthquake engineering facility worldwide

Expansion of SEESL



SEESL "Tomorrow"
Approx. 9000 sq.ft.
of new lab area, incl.
more that 3000 sq.ft.
of new Strong Floor Area

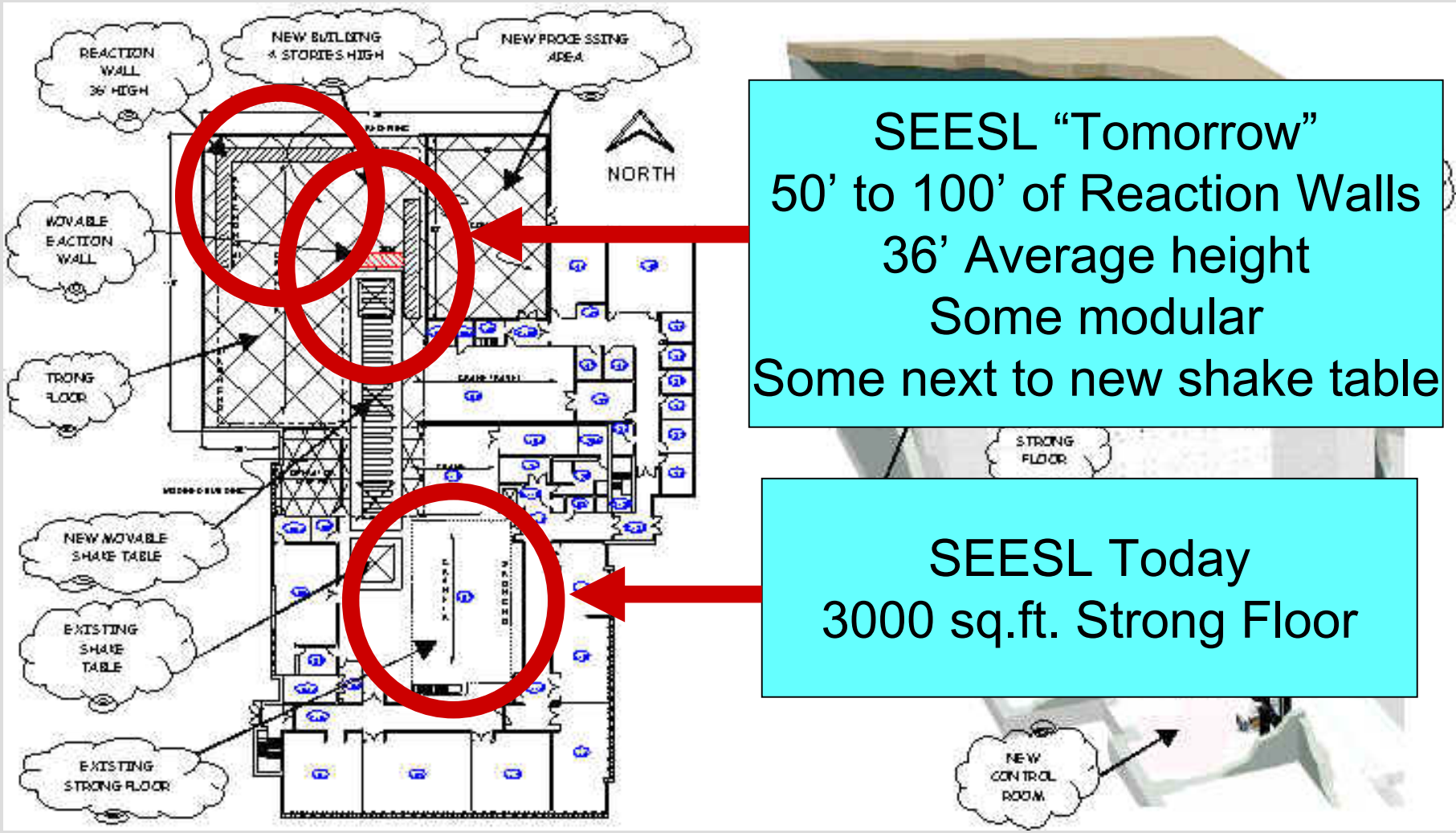
SEESL Today
3000 sq.ft. Strong Floor



NEES Collaboratory Teleparticipation Laboratories

Structural Engineering and Earthquake Simulation Laboratory

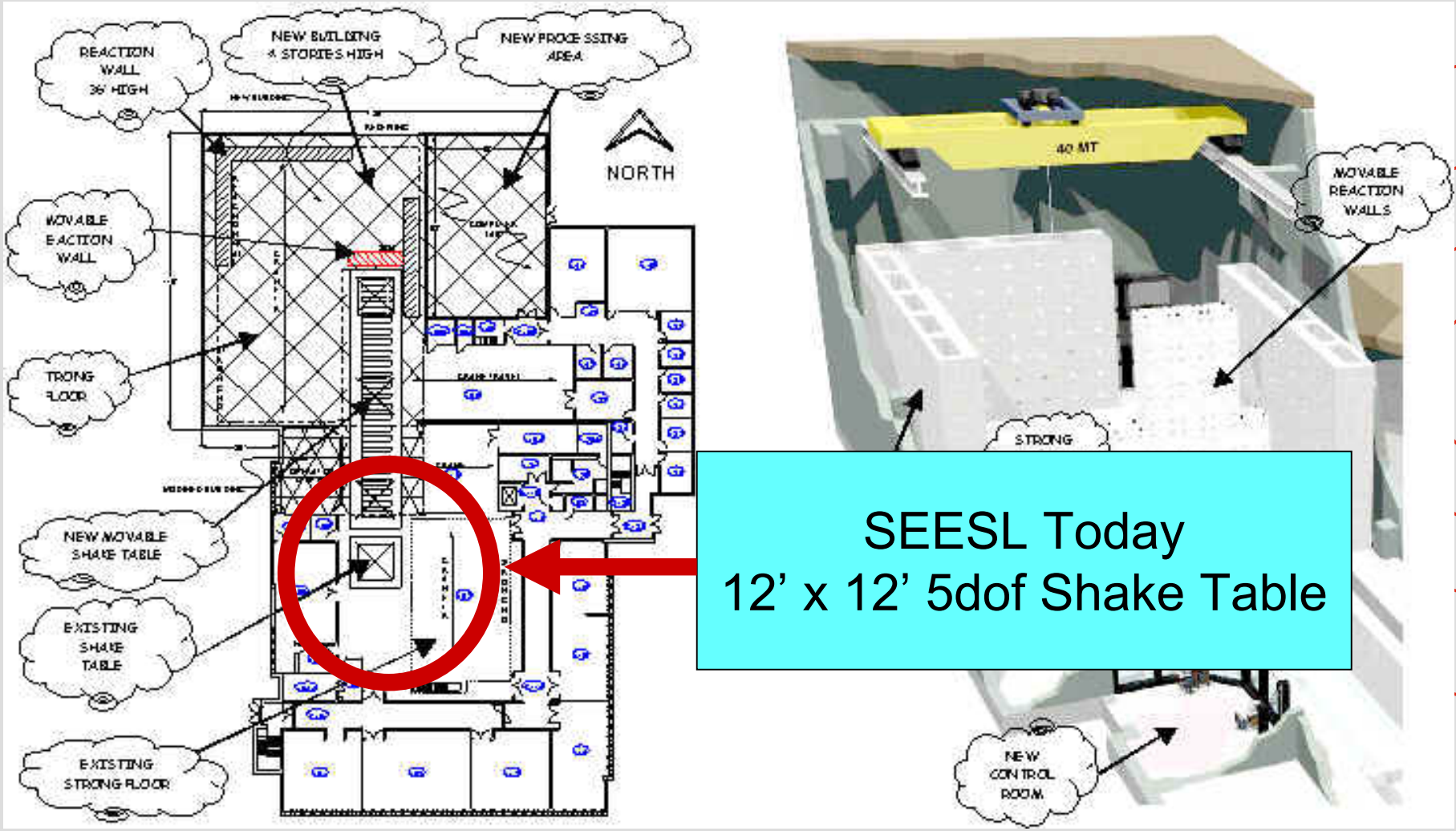
Expansion of SEESL



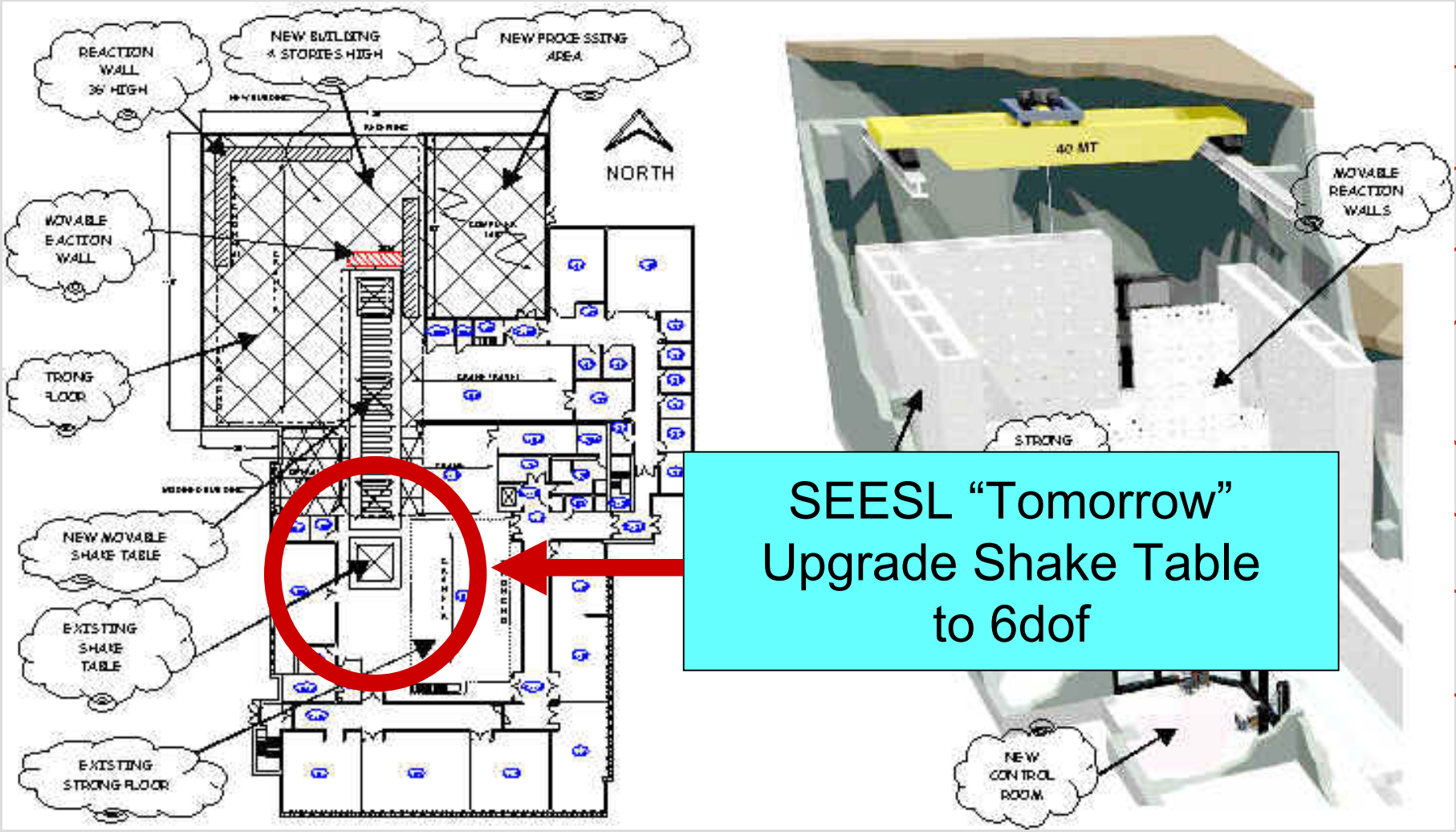
SEESL "Tomorrow"
50' to 100' of Reaction Walls
36' Average height
Some modular
Some next to new shake table

SEESL Today
3000 sq.ft. Strong Floor

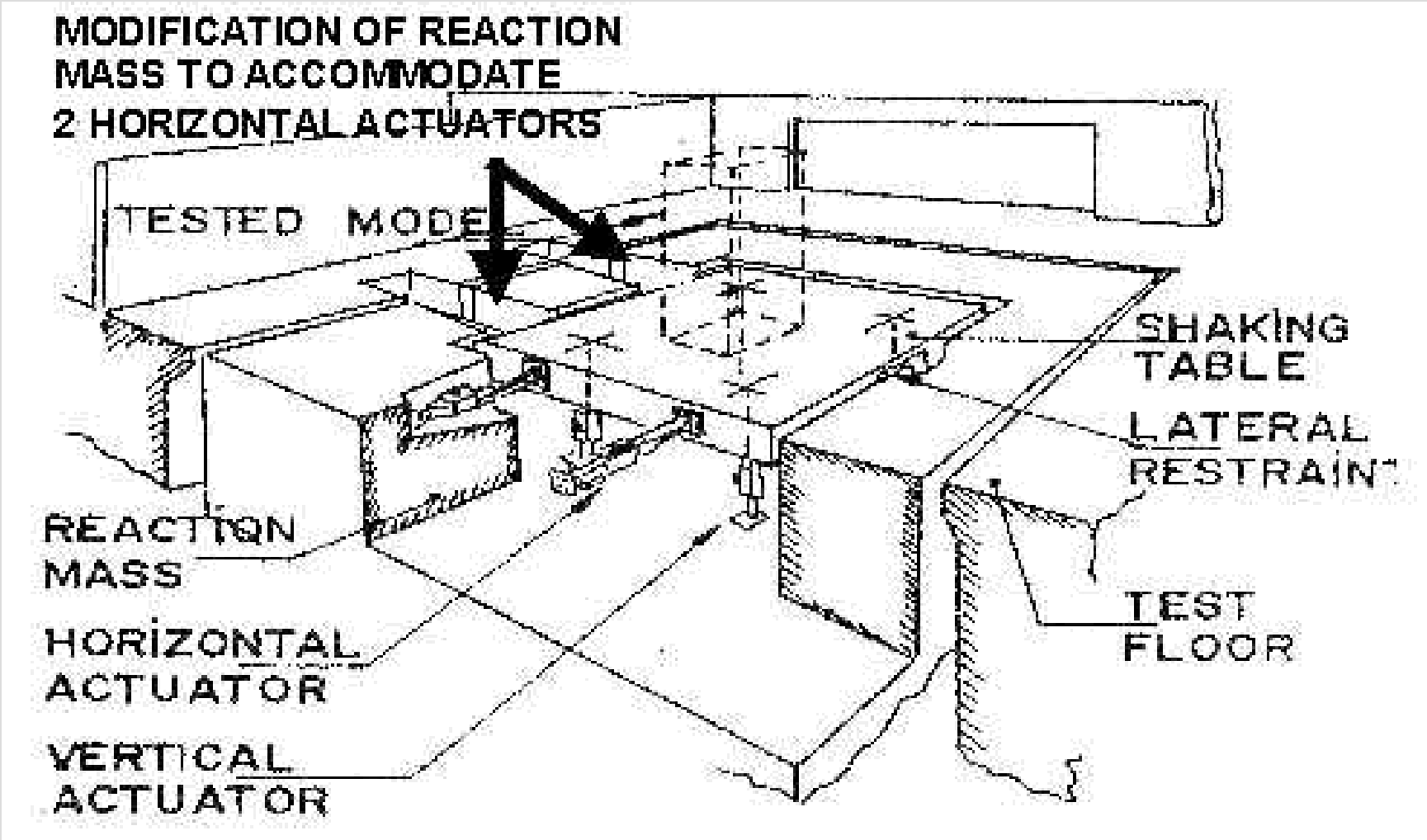
Expansion of SEESL



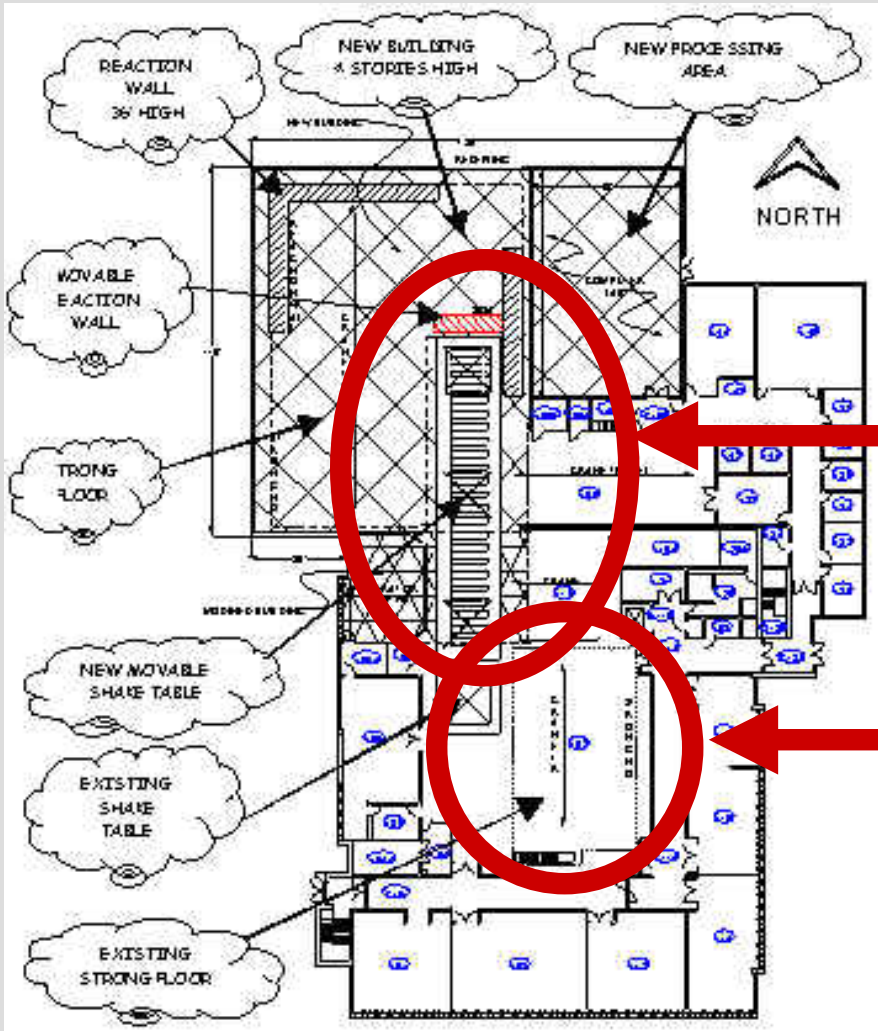
Expansion of SEESL



Existing Shake Table Upgrade



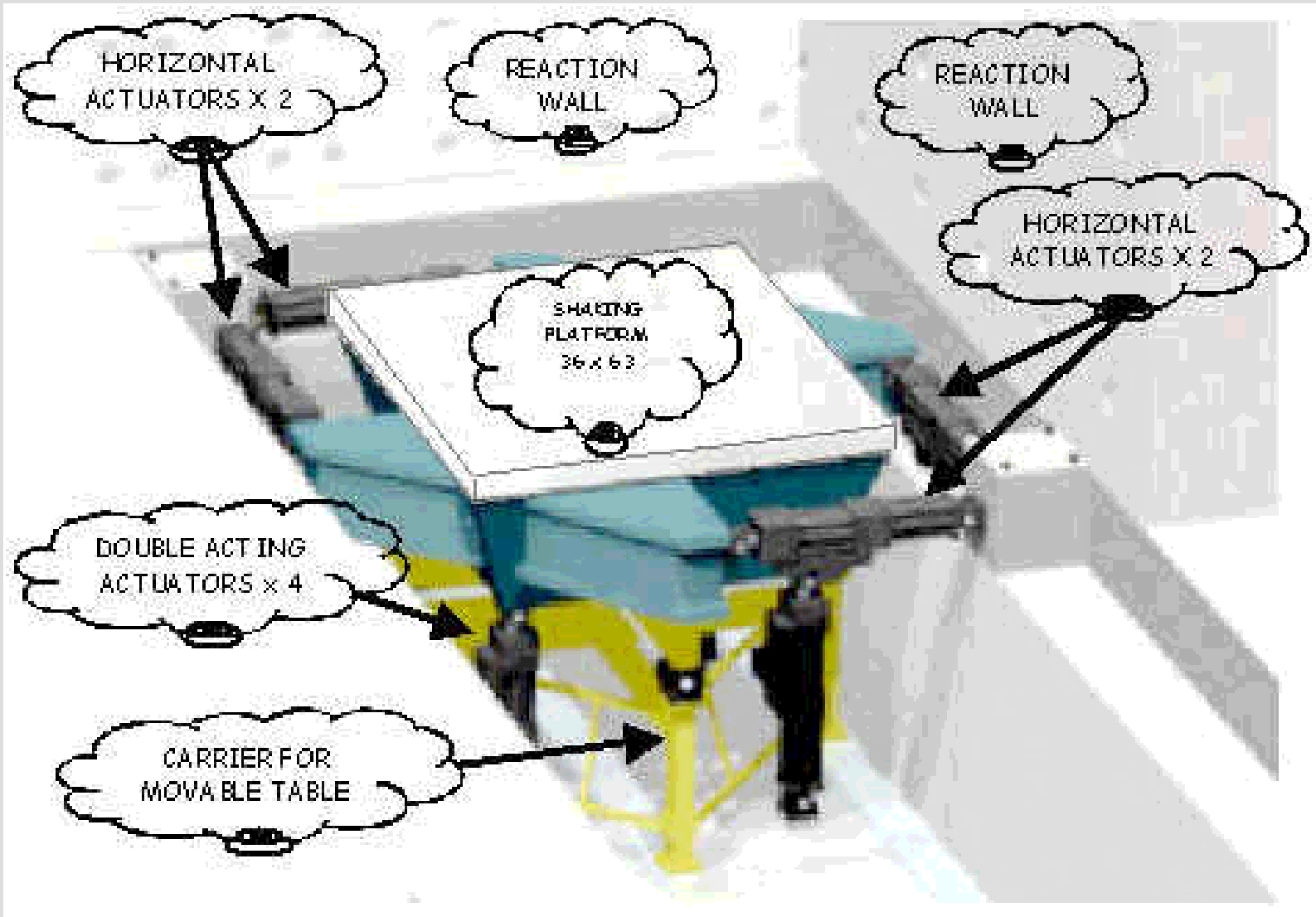
Expansion of SEESL



SEESL "Tomorrow"
New 12' x 12' Shake Table
Comparable in Spec
but
Capable of 100Hz
"Relocatable" in 1-day

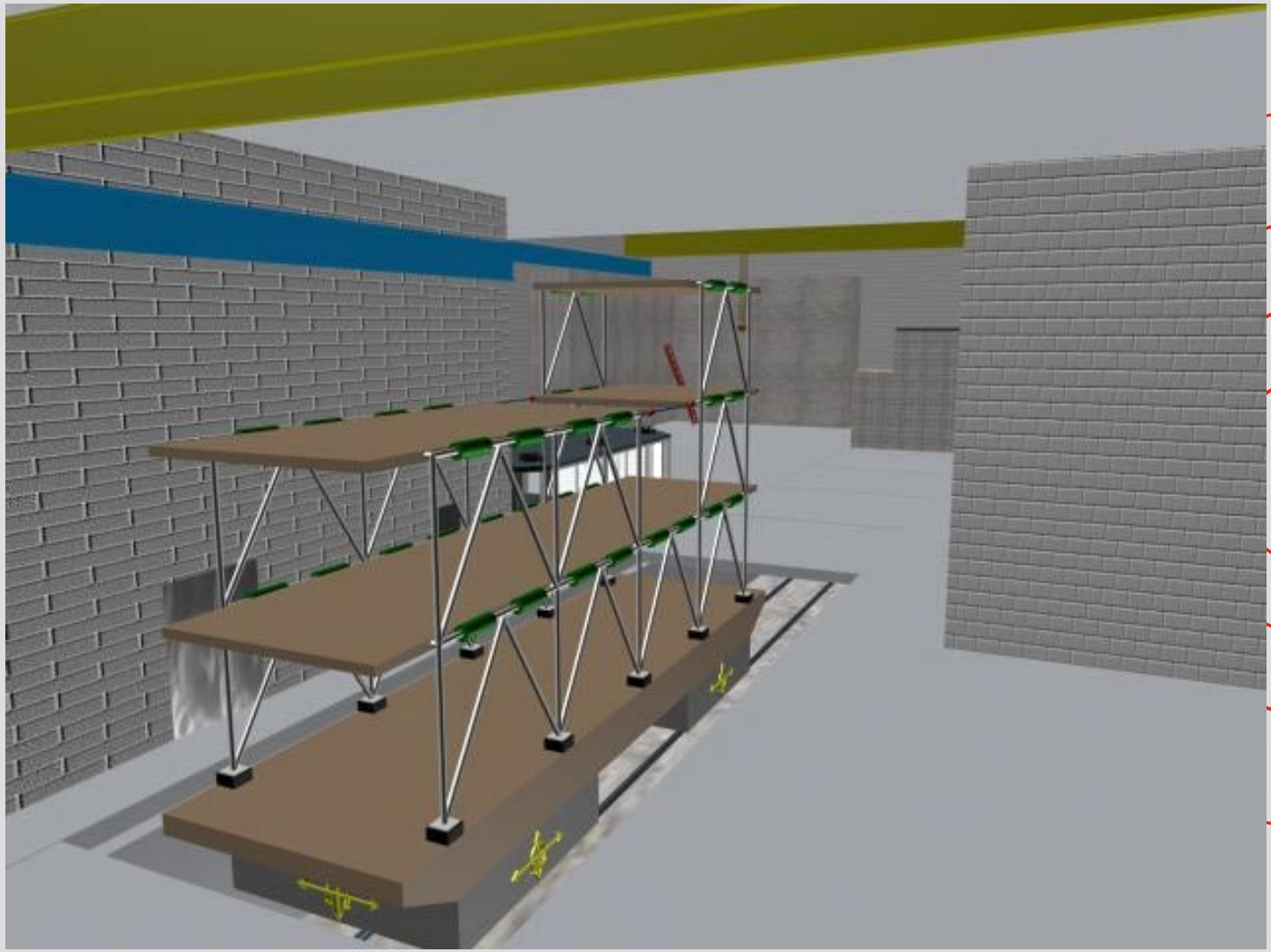
SEESL "Tomorrow"
Upgrade Shake Table
to 6dof

New Shake Table



New Shake Table

- Increased Payload capacity
- Tables can be used close together

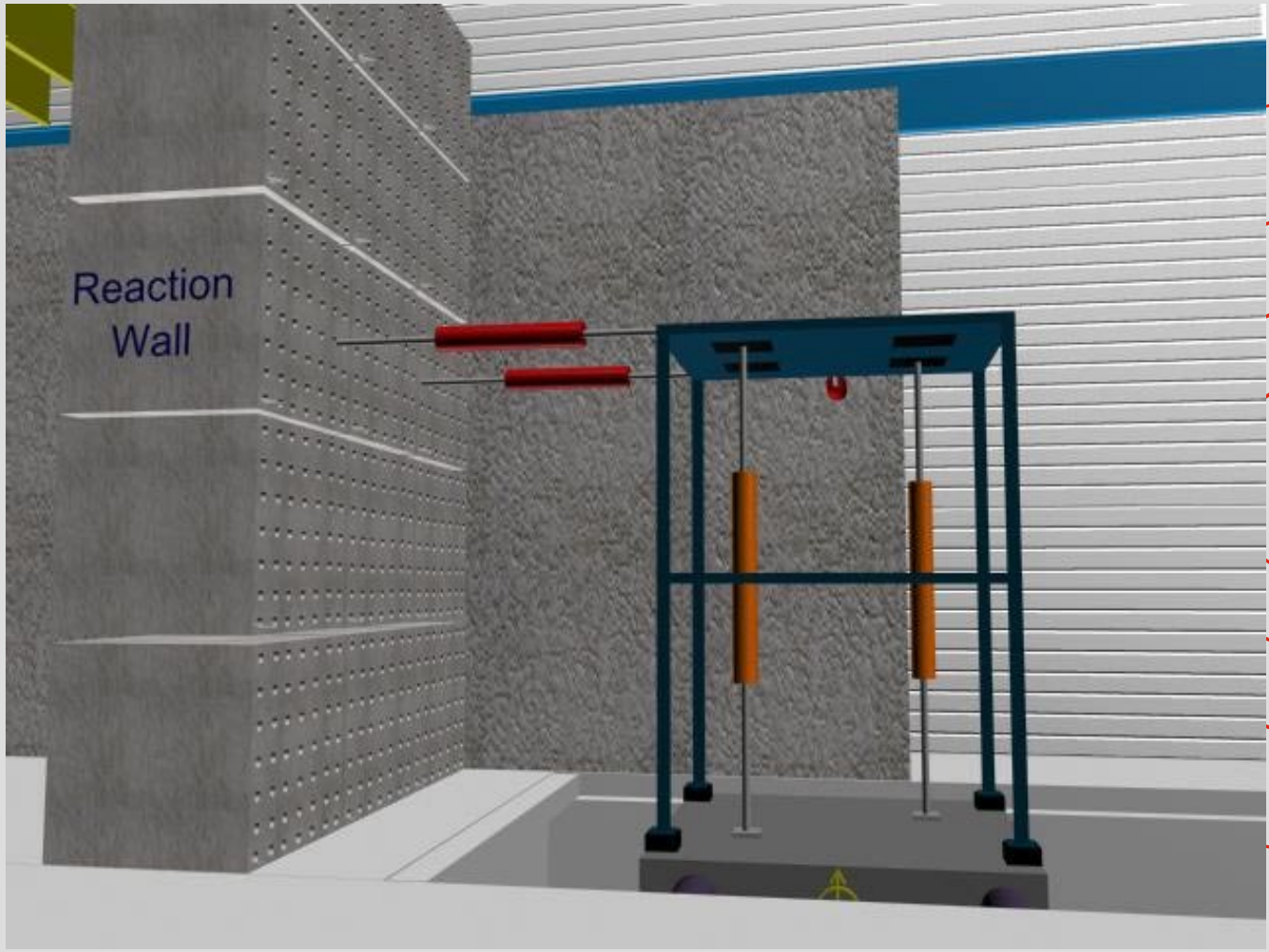


New Shake Table

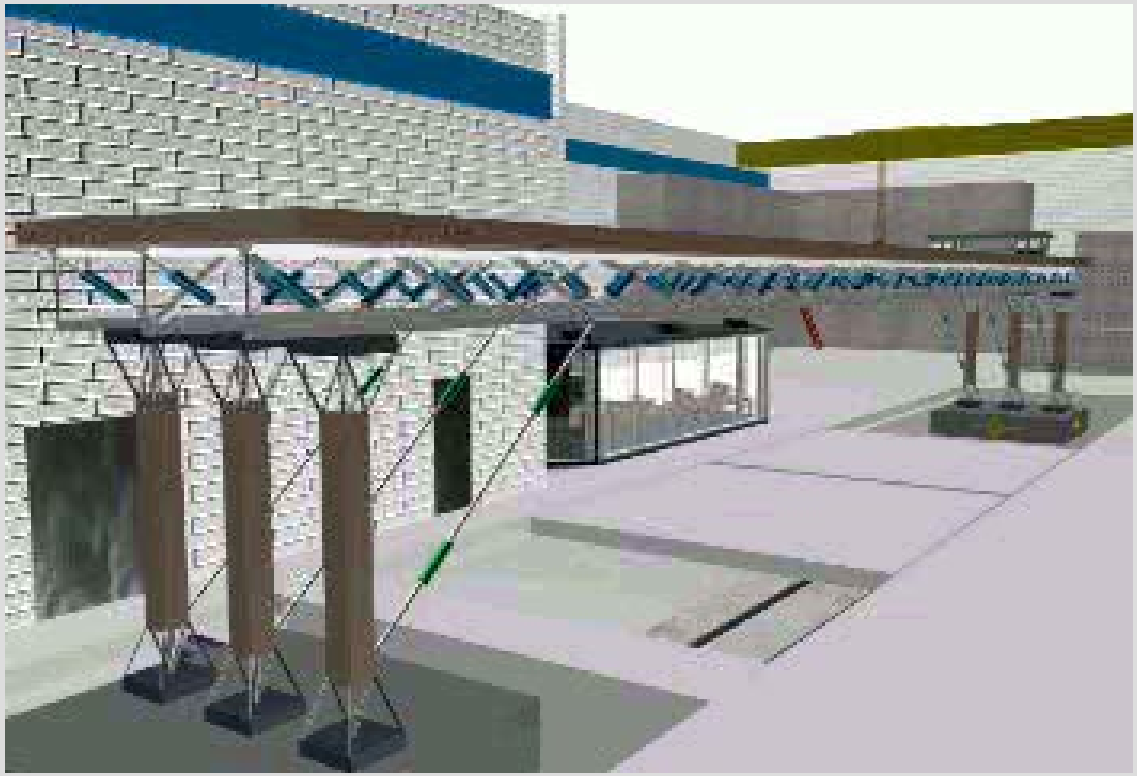
- Increased Payload capacity
- Tables can be used up to 110 ft apart

New Shake Table

- New Shake Table can be used next to reaction wall
- Hybrid testing



Dual Shake-Table Facility



Actuators

- 3 x 100 tons (225,000 lbs) dynamic actuators with dual 400 gpm servovalves, +/- 500 mm (20 in) stroke (can also be used with low-flow servo-valves for pseudo-dynamic testing)
- 2 x 200 tons (500,000) actuators, 15 gpm servovalves, +/- 500 mm (20 in) stroke
- = Total 1,775,000 lbs force capacity

Hydraulic Power Supply

- 50 ft of 1600 gpm distribution line
- Surge tank and 14 banks of 50 gallons each accumulations (700 gal. capacity)
- Two hydraulic pumps of 185 gpm to be linked with existing HPS
- = capacity 1600 gpm continuous for 30 sec.

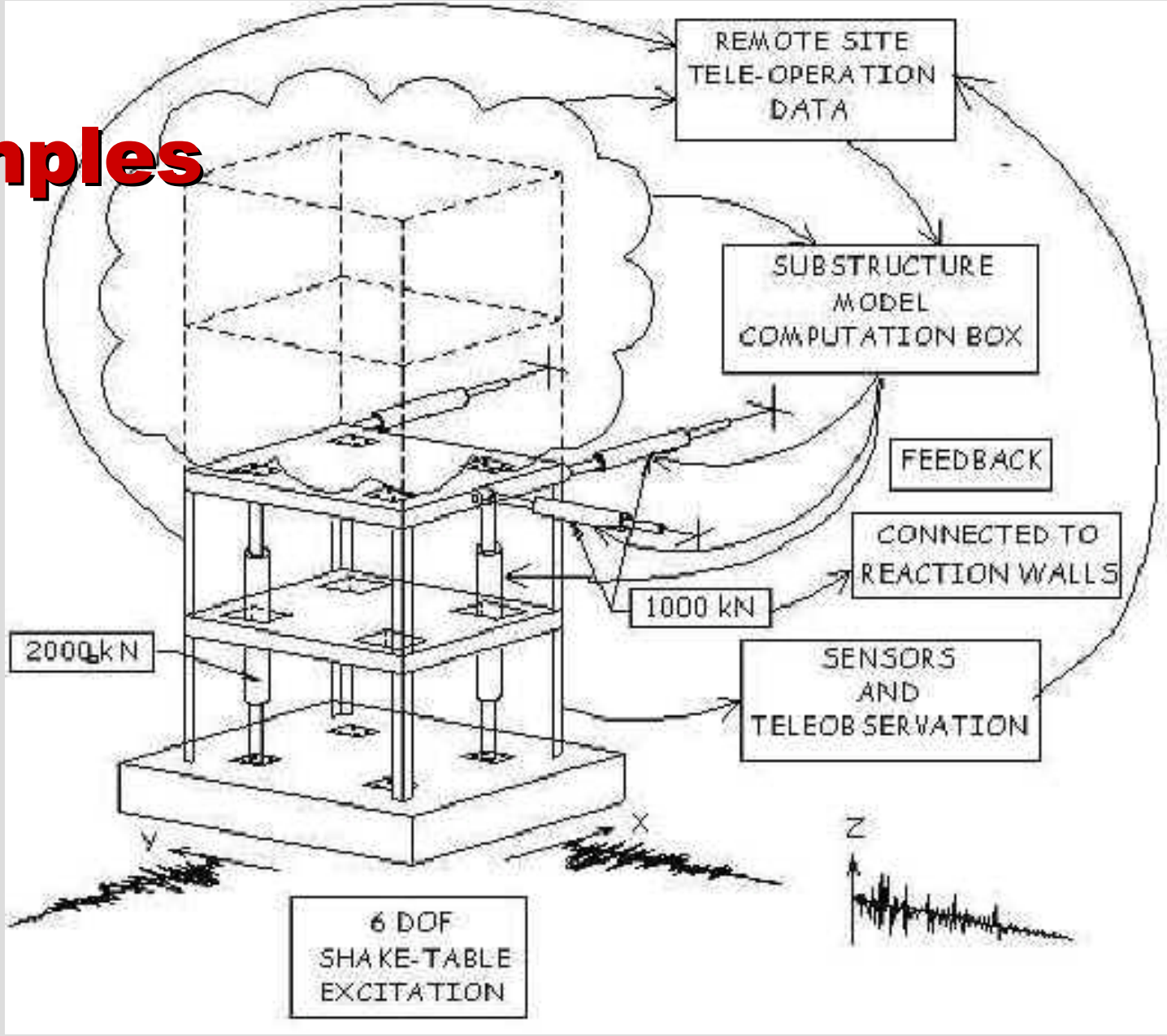
Digital Systems

- Digital Controllers
- Upgrade and expansion of data acquisition system (364 channels, with expansion capability)
- Tele-operation and tele-observation
- Video HDTV imaging equipment
- Data management and processing systems

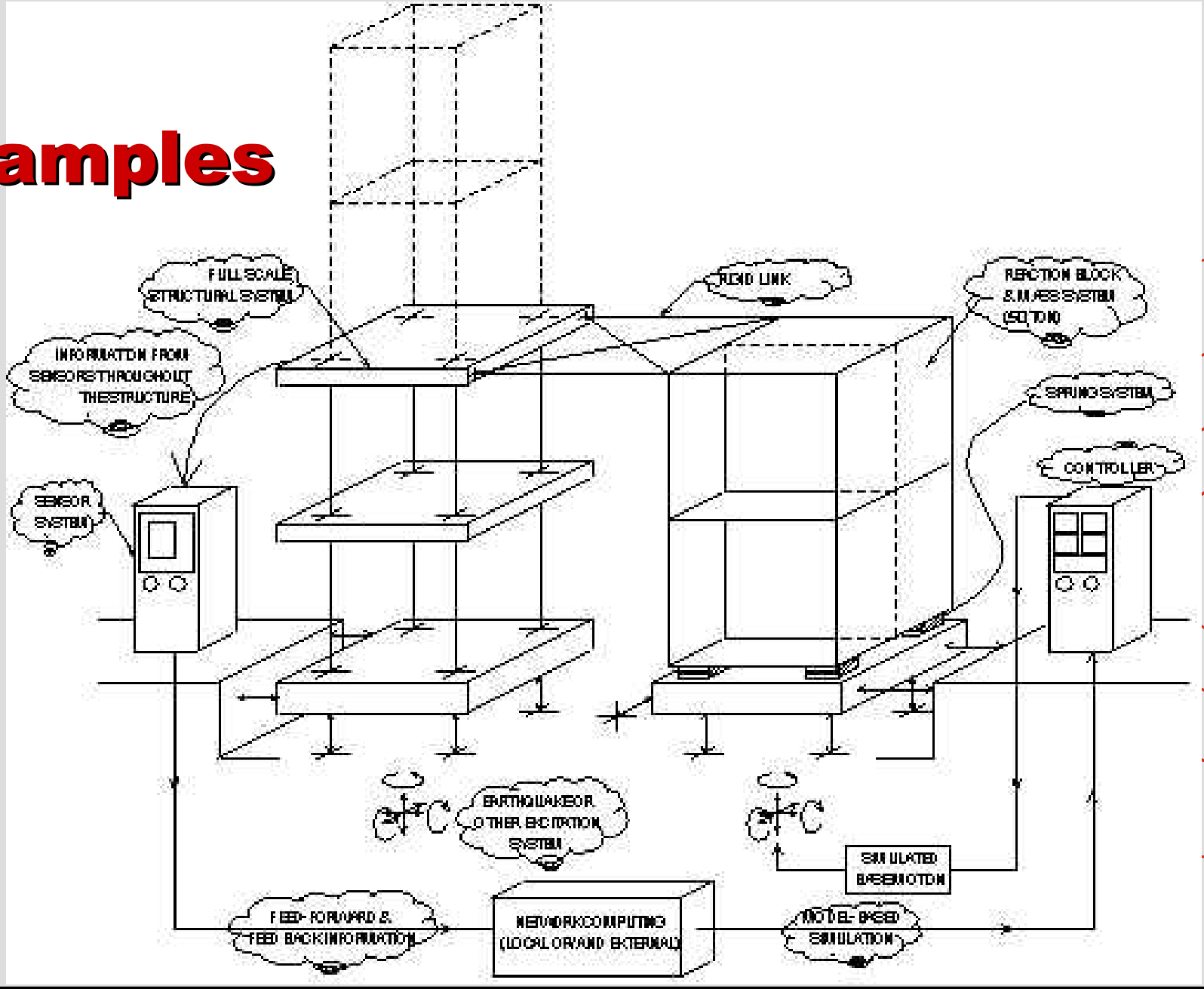
New testing capabilities

- Pseudo-dynamic testing
- Effective Force Method
- Real Time Dynamic Hybrid Testing (new developement)

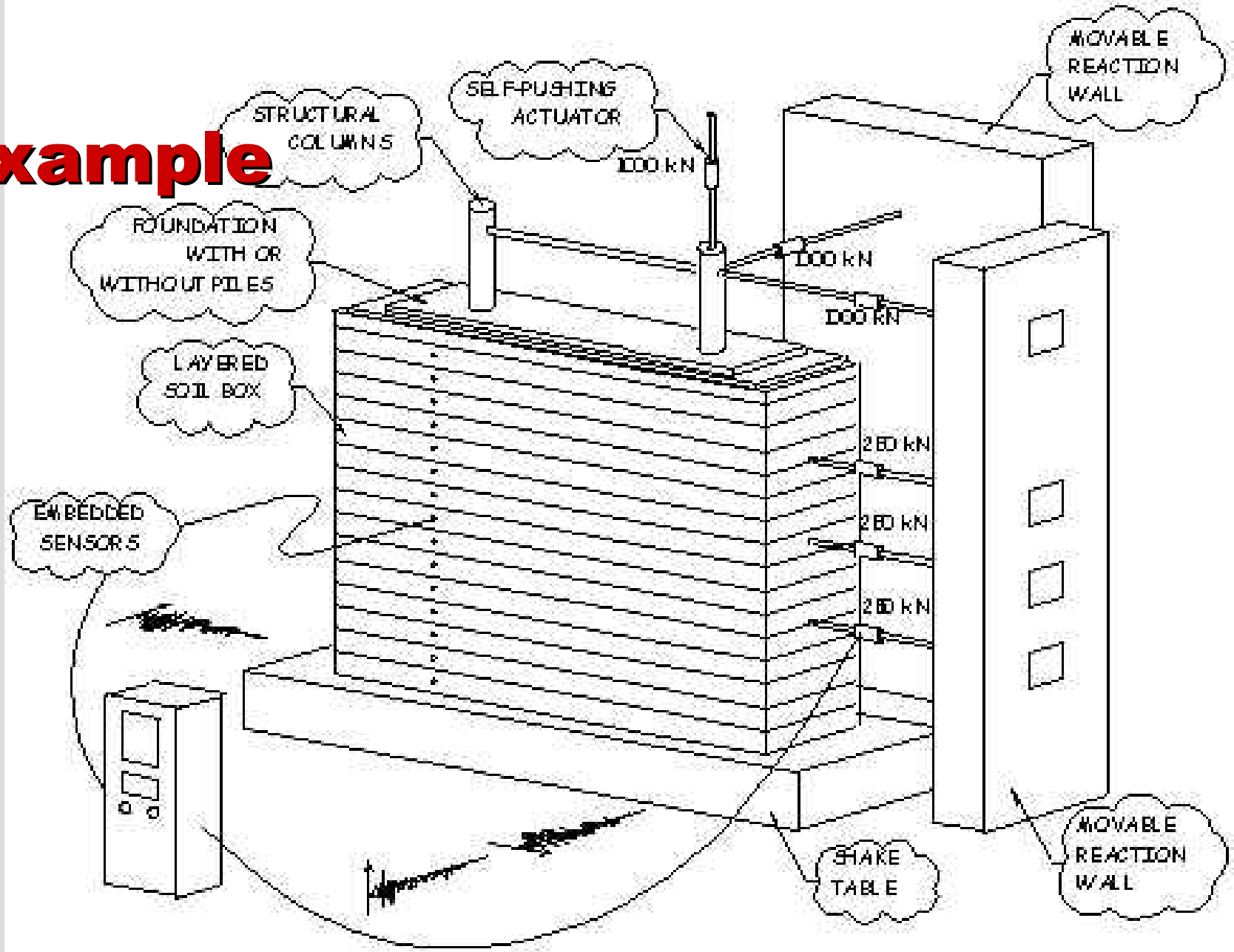
Examples


REMOTE SITE
TELE-OPERATION
DATA
SUBSTRUCTURE
MODEL
COMPUTATION BOX
FEEDBACK
CONNECTED TO
REACTION WALLS
1000 kN
2000 kN
SENSORS
AND
TELEOBSERVATION
Y
X
Z
6 DOF
SHAKE-TABLE
EXCITATION

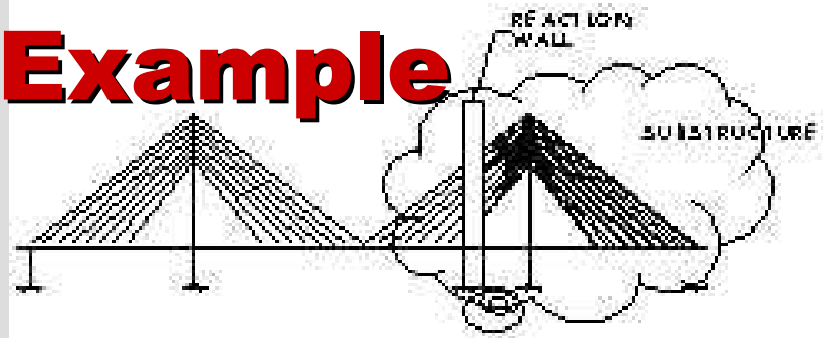
Examples

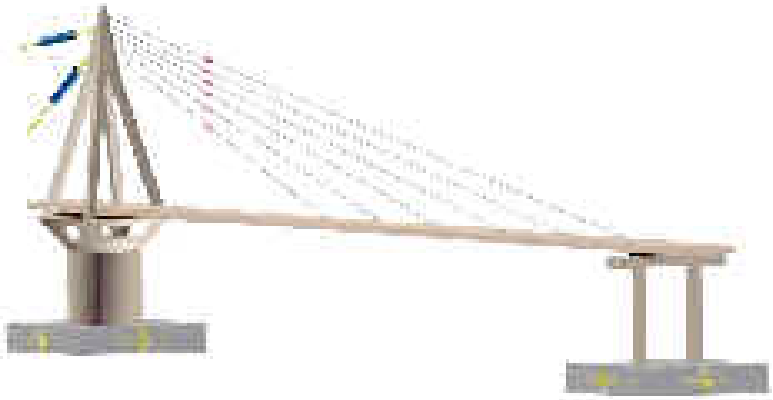

FULL SCALE STRUCTURAL SYSTEM
INFORMATION FROM SENSORS THROUGHOUT THE STRUCTURE
SENSOR SYSTEM
RIGID LINK
REACTION BLOCK & BRACE SYSTEM (SECTION)
SPRING SYSTEM
CONTROLLER
EARTHQUAKE OR OTHER EXCITATION SYSTEM
SIMULATED BASE MOTION
FEED- FORWARD & FEED BACK INFORMATION
NETWORK COMPUTING (LOCAL OR AND EXTERNAL)
MODEL- BASED SIMULATION

Example


STRUCTURAL COLUMNS
SELF-PUSHING ACTUATOR
MOVABLE REACTION WALL
1000 kN
FOUNDATION WITH OR WITHOUT PILES
500 kN
500 kN
LAYERED SOIL BOX
280 kN
280 kN
280 kN
EMBEDDED SENSORS
SHAKE TABLE
MOVABLE REACTION WALL

Example





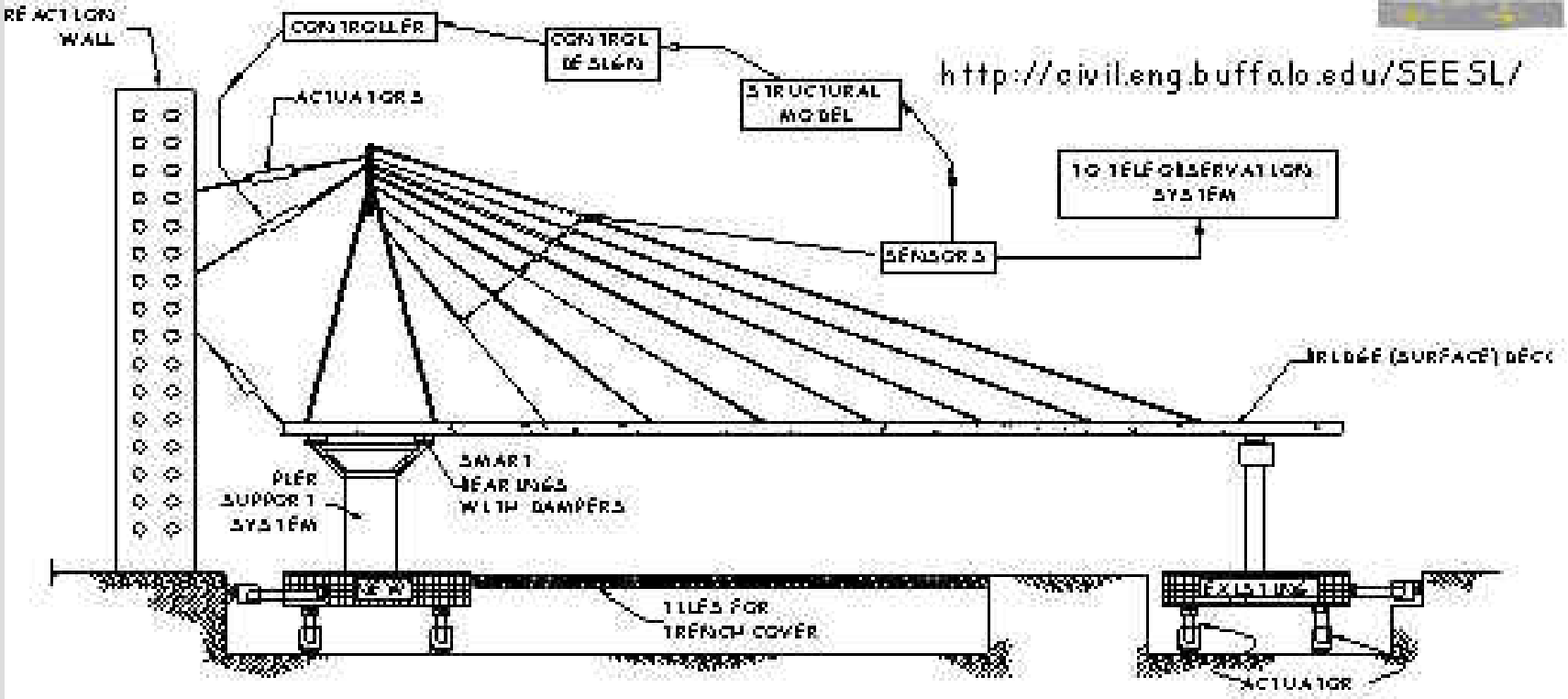


Fig.6. Cable-stayed bridge segment with RTH-STS using two shake tables, reaction walls and large-scale high performance actuators

Example of Hybrid Testing

Conclusion

- State-of-the-Art Earthquake Engineering Lab (NEES-UB node) as part of the National/International NEES Collaboratory
- Tools to develop the next generation of earthquake engineering testing capabilities
- Facility expands range of possible testing, to generate the new knowledge to solve problems that could not be solved otherwise.

Common Challenges with other NEES Equipment Sites

- The greatest challenges do not lie in implementation of the interfacing technology to link the NEES nodes, but rather in the development and implementation of the advanced concepts of integrated distributed analytical and experimental capabilities.